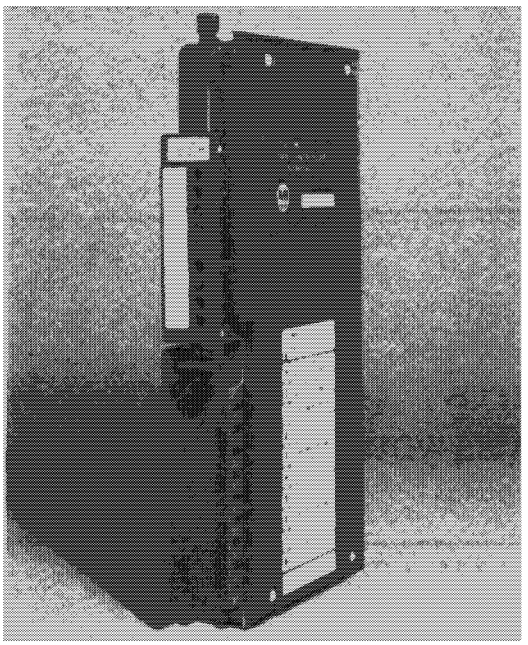
ALLEN-BRADLEY

Loop Controller Interface Module

(Cat. No. 1771-LI)

Product Data



Description

The Loop Controller Interface Module (Cat. No. 1771LI) allows a PLC-2, -3, or -5 to communicate with single loop PID controllers (cat. no. 1771-LC1, -LC2, -LC3, -LC4). The module can communicate with up to 15 loop controllers through an RS-485 serial link.

You can configure a loop controller directly from its keypad or download a configuration from the PLC via the interface module. Table 1 summarizes the module's functions and commands.

Table 1
Interface Module Commands

Function	Command	Command Code
Change the set point, output, and operating mode. Acknowledge alarms.	Set Control	4000
Monitor the set point, output, alarm status, and operating mode.	Loop Status	4000
Change PID parameters, alarm limits, and output limits.	Modify Parameters	0010
Examine PID parameters, alarm limits, and output limits.	Read Parameters	0020
Transfer a configuration from a loop controller	Upload	0004-0007
Transfer a configuration to a loop controller	Download	000C-000F
Gather data from inputs and outputs	Extended Loop Status	0080
Examine error codes	Error Record	00F0

Important: The loop controller must be in the workstation mode before the interface module can change the loop controller's parameters.

1771-LI/1771-LC Compatibility

The chart that follows shows you what features you can use with the 1771-LI/1771-LC modules you have.

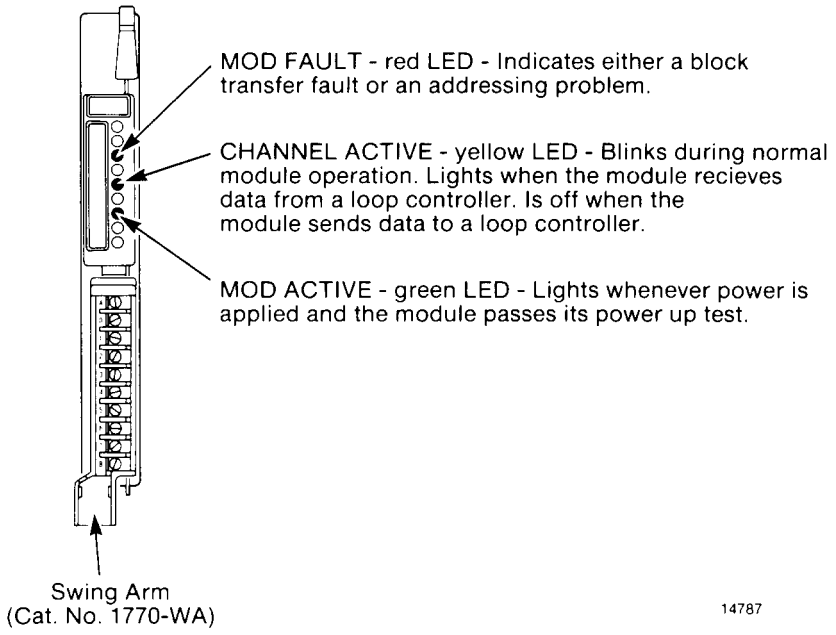
	1771-LC, Series A	1771-LC, Series B
1771-LI, Rev A	Set Control Loop Status	Set Control Loop Status
1771-LI, Rev B	Set Control Loop Status	Set Control Read/Modify Parameters Loop Status Ext. Loop Status Upload Download

For more detailed loop controller information, refer to the Loop Controller User's Manual, publication 1771-6.5.42.

LED Indicators

Three LED indicators on the front of the module indicate the module's current operating status.(Figure 1.)

Figure 1
Loop Controller Interface Module


MOD FAULT - red LED - Indicates either a block transfer fault or an addressing problem.
CHANNEL ACTIVE - yellow LED - Blinks during normal module operation. Lights when the module recieves data from a loop controller. Is off when the module sends data to a loop controller.
MOD ACTIVE - green LED - Lights whenever power is applied and the module passes its power up test.
Swing Arm
(Cat. No. 1770-WA)
14787

Keying Bands

You use the keying bands supplied with the module to key the backplane to accept only the loop controller interface module. The keying bands on the upper backplane connector must correspond with the slots on the module.

The keying bands on the backplane connector are:

- Between 12 and 14
- Between 16 and 18

Installing the Module

To insert a module into the I/O chassis:

1. Remove power from the I/O chassis.
2. Open the module locking latch and insert the interface module into the slot keyed for it.
3. Firmly press the module into its backplane connector.
4. Secure the module in place with the module locking latch.
5. Reconnect power to the I/O chassis.

Connecting the Loop Controller to the Module

The RS-485 serial link allows the module to communicate with up to 15 loop controllers. Connect the two devices with twisted-pair cable suitable for RS-485 wiring. You make these connections at the module's swing arm terminals (cat. no. 1771-WA). The swing arm allows you to remove the module without having to remove the wiring.

Use twinaxial cable (cat. no. 1770-CD) for the serial link or any shielded twisted-pair cable that has a minimum characteristic impedance of 60 ohms and has a maximum capacitance of 75 pF per meter.

Connect the module and loop controllers in a daisychain configuration as long as total cable length does not exceed 4000 ft.

Use the following procedure to connect the loop controller to the module:

1. Strip 2 inches of the outer insulation from the cable end to be connected to the wiring arm.(Figure 2.)
2. Remove the exposed foil.
3. Strip approximately 3/8 inch of insulation from the end of each wire.
4. Connect the wires to the module as shown in figure 3.
5. Repeat steps 1 through 4 for the cable end to be connected to the loop controller's terminal block.

Figure 2
Cable Preparation

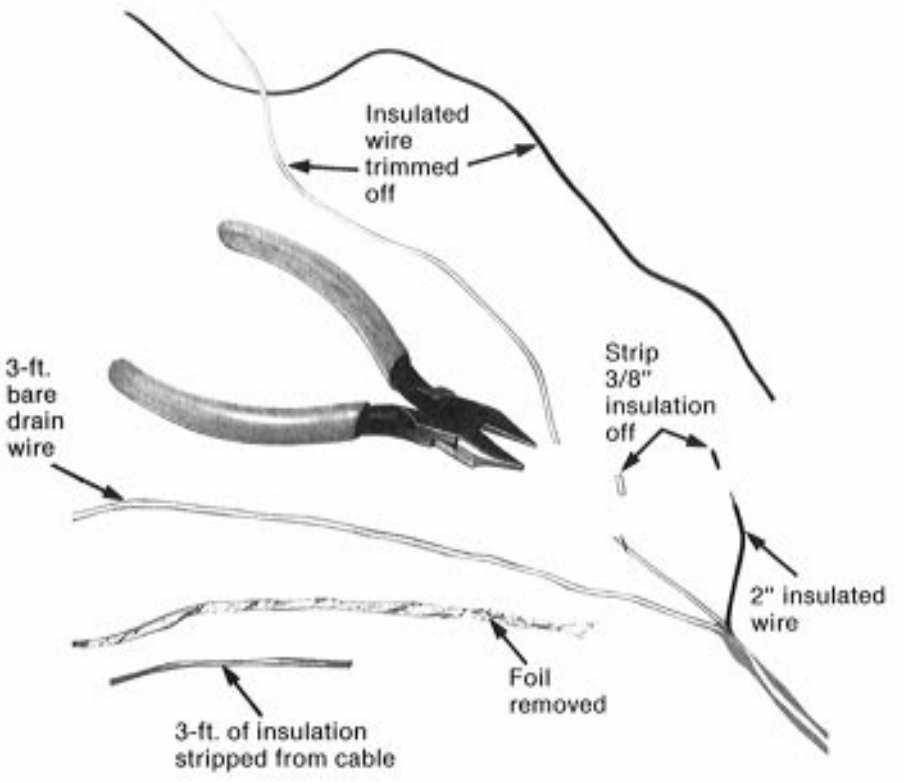
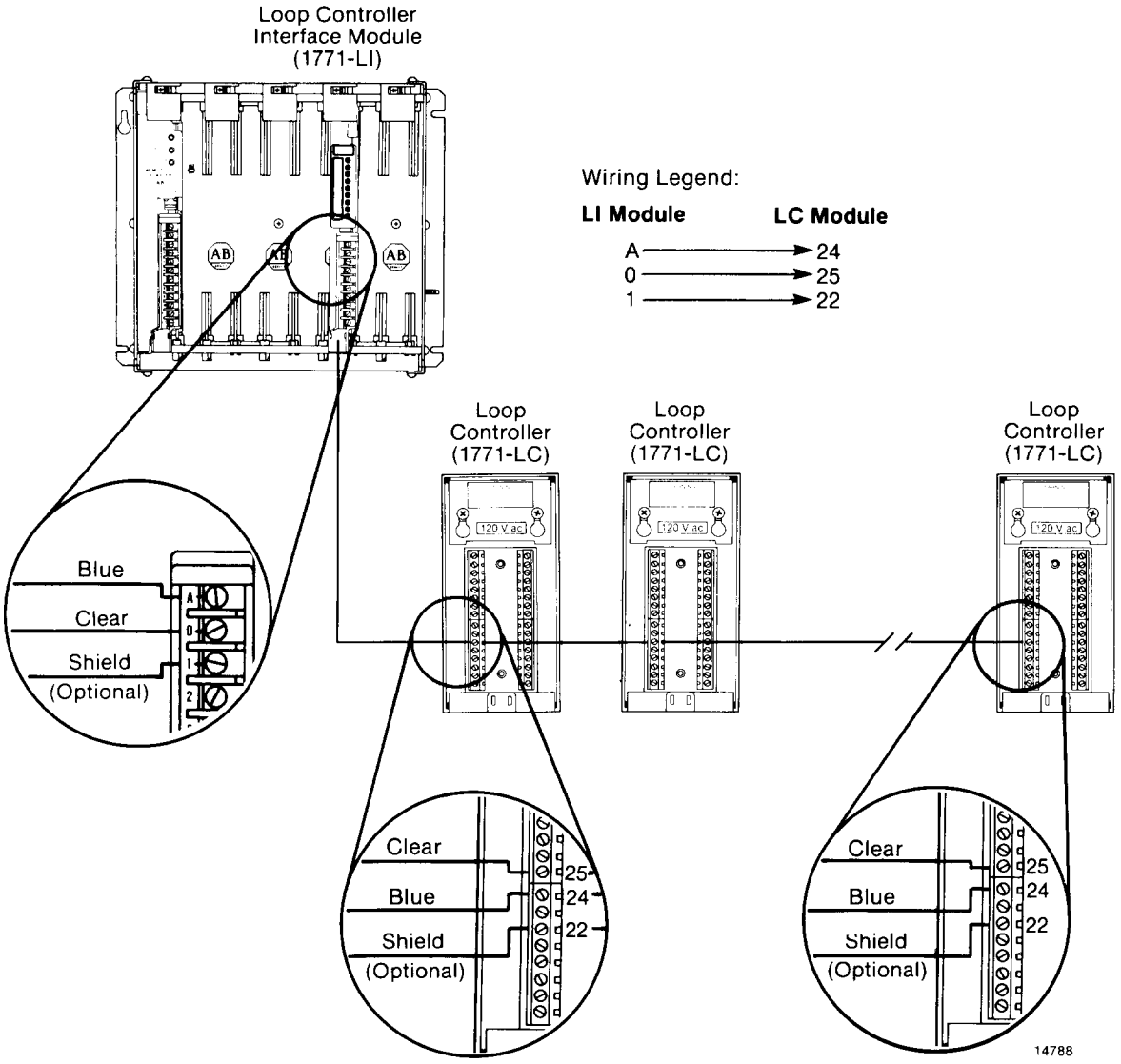


Figure 3
Loop Controller/Interface Module Wiring



Electrostatic Damage

To prevent static damage, we construct, test, and pack our products in a static free environment. We ship our products that require individual protection in bags that are sealed and shielded from static. When removing a product from a bag or disassembling a device, do so in a static safe environment.

CAUTION: If you handle components improperly, the electrostatic discharge can damage them. Handle equipment and components only in a static safe environment.

PLC Data Table Requirements

You must allocate two blocks of memory within the PLC's data table for use by the interface module. The module requires this memory for block transfer read and write files.

The maximum length of the block transfer write file is 64 words. Set the length of the write file to the default value of 00.

The maximum length of the block transfer read file is 64 words. Set the length of the read file to 00 which allows the module to determine the proper file length.

You will also need to allocate portions of the data table for the files related to the module's commands.

Set Control Command

This command enables the PLC to:

- specify the number of loop controllers attached to the communication link
- select either the auto mode or the manual mode
- specify either a remote or local set point
- enter the value of a new set point or output
- acknowledge alarms

The PLC sends the command to the module via block transfer instructions. The module interprets the command and sends the appropriate message out to the loop controllers over the RS-485 serial link.

Important: The loop controller must be in the manual mode to change an output. The loop controller can be in either the automatic or manual mode when changing a set point.

Set control setpoint/output values are four-digit BCD numbers which represent percent of scale. These values can range between -2.0 and + 102.0. Negative values have their most significant bit set.

The first word of the set control file is the block header. Refer to figure 4. This word (4000) indicates that this is the beginning of the set control file. The second word is loop controller select. You use this word to select the loop controller whose parameters you want to change. Note that the least significant bit is reserved. In the third word you place the address of the last loop controller connected to the interface module. The fourth word is reserved.

Next, the file contains three words for each loop controller (15 loop controllers maximum).

The fifth word is the address of the first loop controller. Set control, the sixth word, allows you to select the changes for loop controller one. The seventh word holds the new set point or output value. The second loop controller's section of memory (three words) begins with word eight.

Setting the Last Controller Address

To ensure optimum loop performance, you must consecutively number the loop controllers connected to the serial link. Begin with number one and do not skip any numbers when you number them.

You specify the number of loop controllers in the set control file. (Refer to figure 4.)

Initially, the file must contain:

- first word – block header of 4000
- second word – station select value of 0000
- third word – the number of the last loop controller, e.g. for five loop controllers, the value is 0005 (values range from 0001 to 0015)
- fourth word – reserved – do not use

Changing Loop Controller Parameters Through the PLC

You use the set control command to change certain loop controller parameters. (Refer to figure 4.)

To change a set point value, for example, you:

- use the station select word to select the loop controller to receive the new set point
- use the set control word of the selected loop controller to indicate that a new value is being entered and that the new value is a set point
- place the loop controller in the automatic mode
- enter the new set point

Acknowledging Alarms from the PLC

If a configured alarm condition develops, the alarm indicator on the front of the loop controller flashes. Also, the corresponding alarm bits are set to 1 in the alarm status word (loop status file).

The indicator continues to flash until you acknowledge the alarm. You acknowledge the alarm either by pressing the ACK key on the loop controller or through the PLC. Once you acknowledge the alarm the indicator stops flashing but remains lit until you correct the problem. Refer to the Loop Controller User's Manual, publication 1771-6.5.42, for additional information.

To acknowledge an alarm from the PLC, set bit 7 (alarm acknowledge) of the set control word for that loop controller.

Monitoring the Loop Controller's Configuration

Whenever you advance past the loop controller's configuration passcode, the front panel change indicator (bit 0) of the loop controller alarm/ status word is set.

You acknowledge the advance past the configuration passcode by setting the user interface acknowledge bit of the set control command (bit 2). This resets bit 0 of the loop status word.

Figure 4
Set Control Format – (Block Transfer Write)

Word #	Set Control Values	
1	4 0 0 0	(A)
2	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 RS	(B)
3	0 0 LAST CONTROLLER ADDRESS	(C)
4	RESERVED	(D)
5	0 0 0 1	(E)
6	0 0 SET CONTROL	(F)
7	S 1 0 2 . 0	(G)
	(H)	
↓		
47	0 0 1 5	(I)
48	0 0 SET CONTROL	(J)
49	S 1 0 2 . 0	(K)
	(H)	

(A) Block header
(B) Loop controller select (RS=reserved)
(C) Last loop controller address
(D) Reserved word
(E) Loop controller (1) address
(F) Set control word (LC 1)
(G) New setpoint or output value (S=sign bit) (LC 1)
(H) Implied decimal point
(I) Loop controller (15) address
(J) Set Control Word (LC 15)
(K) New setpoint or output value (S=sign bit) (LC 15)

Set Control Word Bit Definitions

Bit	Definition
0	New value specified
1	A/M select (0 = manual, 1 = auto)
2	User interface acknowledge
3	R/L setpoint select (0 = local, 1 = remote)
4	Reserved
5	New value select (0 = output, 1 = setpoint)
6	Reserved
7	Alarm acknowledge

Loop Status

Loop status is the module's response to a set control command from the PLC. Loop status is also the module's default response when no set control command is issued.

The data in this file represents each loop controller's current set point, measurement, output, alarms, and status.

Loop Status File

The first four words of the loop status file contain loop controller selection and diagnostic information that applies to all loop controllers connected to the interface module. (Figure 5.)

The first word, the block header, indicates that this is the beginning of the loop status file. The second word, loop controller select acknowledge, shows which loop controllers responded to the most recent set control command. The third word, the no response word, indicates which loop controllers did not respond when polled. Note that bit 0 of words two and three is reserved. The fourth word, the diagnostic word, shows which loop controller has an improper value in the last set control command.

Each loop controller has a four-word reserved area of memory in the loop status file. The first word in each loop controller's area is the alarm/status word which indicates the loop controller's current status. The three remaining words contain three values that reflect the loop's current operating values: set point, measurement, and output. These values are fourdigit BCD numbers which represent percent of scale. The values can range from -2.0 to + 102.0. Negative values have their most significant bit set.

The module continuously polls each loop controller for its current status. When a loop controller responds, the interface module places the updated status values in the loop controller's area. When a loop controller does not respond to a module's status request, its area contains all zeroes. If a loop controller does not respond to a status request after three tries, the interface module sets a bit in the no response word.

Figure 5
Loop Status File Format – (Block Transfer Read)

Word #	Loop Status Values	
1	4 0 0 0	(A)
2	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 RS	(B)
3	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 RS	(C)
4	DIAGNOSTIC WORD	(D)
5	LOOP CONTROLLER ALARM LOOP CONTROLLER STATUS	(E)
6	S 1 0 2 . 0	(F)
7	S 1 0 2 . 0	(G)
8	S 1 0 2 . 0	(H)
	(I)	
↓		
61	LOOP CONTROLLER ALARM LOOP CONTROLLER STATUS	(J)
62	S 1 0 2 . 0	(K)
63	S 1 0 2 . 0	(L)
64	S 1 0 2 . 0	(M)
	(I)	

(A) Block header
(B) Loop controller select acknowledge (RS=reserved)
(C) No response/CRC (RS=reserved)
(D) Diagnostic word
(E) Alarm/status word (LC 1)
(F) Setpoint value (LC 1)
(G) Measurement value (LC 1)
(H) Output value (LC 1)
(I) Implied decimal point
(J) Alarm/Status word (LC 15)
(K) Setpoint value (LC 15)
(L) Measurement value (LC 15)
(M) Output value (LC 15)

Loop Controller Alarm/Status Word

Bit	Definition
0	Front Panel Change Indicator
2	A/M Setting (0 = manual, 1 = auto)
1	W/P Setting (0 = panel, 1 = workstation)
3	R/L Setpoint select (0 = local, 1 = remote)
4	Undefined
5	Undefined
6	Undefined
7	Alarm Indicator (1 = at least one alarm is active)
10	Alarm 4 H/L (0 = low-level 2, 1 = high-level 1)
11	Alarm 4 Valid (1 = alarm is active)
12	Alarm 3 H/L
13	Alarm 3 Valid
14	Alarm 2 H/L
15	Alarm 2 Valid
16	Alarm 1 H/L
17	Alarm 1 Valid

Diagnostic Word

Bits	Definition
0–7	Controller Address (2-digit BCD)
10–17	Error Code (2-digit BCD) 01 = Improper BCD Value 02 = New Value Is Out Of Range 08 = Last Loop Controller Address in the Set Control File Does Not Match the Address in Loop Status

Modify Parameters

The PLC uses the modify parameters command to change the loop controller's:

- PID parameters
- alarm limits
- output limits

Once you use the read parameters command to examine the current loop controller parameters, you can use the modify parameters command to change these parameters.

Important: Changes you make when the loop controller is in the automatic mode affect the controller's operation as soon as it receives the command from the interface module.

Figure 6 shows the command's format. All values are in BCD. The error file reflects any detected BCD errors. The module verifies that each BCD value is valid and falls within a specified range.

The file's first word is the block header which indicates the beginning of the modify parameters file. The second word, loop controller address, identifies the loop controller whose PID parameters you want to alter. Words three through five contain the PID parameters while words six through 13 contain alarm limits. Words 14 and 15 hold the upper and lower output limit values.

When the loop controller receives the command from the PLC it sends a modify parameter acknowledge value back to the PLC. Refer to figure 7. If an error occurs, the error file displays the appropriate error code.

Figure 6
Modify Parameter File Format - (Block Transfer Write)

Word #	Modify Parameter Values					
1	0	0	1		0	(A)
2	0	0	LOOP CONTROLLER ADDRESS			(B)
3	0	5	0	.	0	(C)
4	0	0	1	.	0	(D)
5	0	0	0	.	5	(E)
6	0	4	0	.	0	(F)
7	0	6	0	.	0	(G)
8	0	4	0	.	0	(H)
9	0	6	0	.	0	(I)
10	0	4	0	.	0	(J)
11	0	6	0	.	0	(K)
12	0	4	0	.	0	(L)
13	0	6	0	.	0	(M)
14	0	9	8	.	0	(N)
15	0	1	5	.	0	(O)
				(P)		

(A) Block Header
(B) Loop Controller Address (01-15)
(C) Proportional Band (1 to 8000%)
(D) Integral Time (0.1 to 200.0 Minutes)
(E) Derivative Time (0.1 to 100.0 Minutes)
(F) Alarm 1 - Level 1 (-99.9 to 102.0%)
(G) Alarm 1 - Level 2 (-99.9 to 102.0%)
(H) Alarm 2 - Level 1 (-99.9 to 102.0%)
(I) Alarm 2 - Level 2 (-99.9 to 102.0%)
(J) Alarm 3 - Level 1 (-99.9 to 102.0%)
(K) Alarm 3 - Level 2 (-99.9 to 102.0%)
(L) Alarm 4 - Level 1 (-99.9 to 102.0%)
(M) Alarm 4 - Level 2 (-99.9 to 102.0%)
(N) Output - Upper Limit (-2.0 to 102.0)
(O) Output - Lower Limit (-2.0 to 102.0)
(P) Implied Decimal Point

Figure 7
Modify Parameter Command – (Block Transfer Read)

Word #					
1	0	0	1	0	(A)
2	0	0	LOOP CONTROLLER ADDRESS		(B)

(A) Block Header
(B) Loop Controller Address

Read Parameters

The read parameter command enables the PLC to read the loop controller's current:

- PID parameters
- alarm limits
- output limits

After you examine the loop controller parameters and limits, you can change them by using the modify parameters command.

Figure 8 shows the command's format. The first word is the block header which indicates the beginning of the read parameters file. The second word, loop controller address, identifies the loop controller whose parameters you want to read.

When the loop controller acknowledges this command, it sends a reply to the PLC. Refer to figure 9. The format is the same as the modify parameters format.

Figure 8
Read Parameter Request – (Block Transfer Write)

Word #					
1	0	0	2	0	(A)
2	0	0	LOOP CONTROLLER ADDRESS		(B)

(A) Block Header
(B) Loop Controller Address

Figure 9
Read Parameter Response File Format – (Block Transfer Read)

Word #					
1	0	0	2	0	(A)
2	0	0	LOOP CONTROLLER ADDRESS		(B)
3	0	5	0	0	(C)
4	0	0	1	0	(D)
5	0	0	0	0	(E)
6	0	4	0	0	(F)
7	0	6	0	0	(G)
8	0	4	0	0	(H)
9	0	6	0	0	(I)
10	0	4	0	0	(J)
11	0	6	0	0	(K)
12	0	4	0	0	(L)
13	0	6	0	0	(M)
14	0	9	8	0	(N)
15	0	1	5	0	(O)

(A) Block Header
(B) Loop Controller Address (01-15)
(C) Proportional Band (1 to 8000%)
(D) Integral Time (0.1 to 200.0 Minutes)
(E) Derivative Time (0.1 to 100.0 Minutes)
(F) Alarm 1 – Level 1 (-99.9 to 102.0%)
(G) Alarm 1 – Level 2 (-99.9 to 102.0%)
(H) Alarm 2 – Level 1 (-99.9 to 102.0%)
(I) Alarm 2 – Level 2 (-99.9 to 102.0%)
(J) Alarm 3 – Level 1 (-99.9 to 102.0%)
(K) Alarm 3 – Level 2 (-99.9 to 102.0%)
(L) Alarm 4 – Level 1 (-99.9 to 102.0%)
(M) Alarm 4 – Level 2 (-99.9 to 102.0%)
(N) Output – Upper Limit (-2.0 to 102.0)
(O) Output – Lower Limit (-2.0 to 102.0)
(P) Implied Decimal Point

Upload

The upload command allows you to store a loop controller's configuration in the PLC's data table. Note that the configuration data is not in readable form. You use the download command to transfer this stored configuration back to a loop controller at a later time.

The upload command permits the PLC to read the loop controller's memory using four block transfer read operations. Each block transfer moves a specific section of loop controller memory (64 words each).

Figure 10 shows the format of the upload command(s).Notice that the only difference between the commands is the command code.

When the loop controller acknowledges the PLC's request, it begins sending data. Refer to figure 11.

The interface module calculates a checksum value as each block of data transfers from the loop controller to the PLC. This checksum is used to verify that no data sent to the PLC was altered.

Caution: Do not alter the data that you transferred to the PLC. If you alter the data and download it to the loop controller without proper testing, unexpected process control could result.

Figure 10
Upload Command Format – (Block Transfer Write)

Word #					
1	0	0	0	4	(A)
2	0	0	LOOP CONTROLLER ADDRESS		(B)

(A) Block Header – 0004, 0005, 0006, and 0007
(B) Loop Controller Address

Figure 11
Upload File Format – (Block Transfer Read)

Word #					
1	0	0	2	0	(A)
2	0	0	LOOP CONTROLLER ADDRESS		(B)
3	0	5	0	0	(C)
63					
64					

(A) Block Header – 0004, 0005, 0006, and 0007
(B) Loop Controller Address
(C) Beginning of Configuration Data
(D) End of Configuration Data
(E) Checksum

Download

The download command enables the PLC to send back to a loop controller the contents of memory previously uploaded to the data table. The download command is actually four commands as shown in figure 12. The PLC uses the four block transfer write operations to transfer the memory contents back to the loop controller. The loop controller should be in the manual mode when you transfer data from the PLC.

The interface module calculates a checksum as the data transfers back to the loop controller. The module then compares the download checksum to the internally calculated checksum to verify that no data was altered.

When the loop controller accepts the data transferred from the PLC, it sends an acknowledgement as shown in figure 13.

Figure 12
Download File Format – (Block Transfer Write)

Word #					
1	0	0	0	C	(A)
2	0	0	LOOP CONTROLLER ADDRESS		(B)
3					(C)
63					
64					

(A) Block Header – 000C, 000D, 000E, and 000F
(B) Loop Controller Address
(C) Beginning of Configuration Data
(D) End of Configuration Data
(E) Checksum

Figure 13
Download Acknowledge – (Block Transfer Read)

Word #					
1	0	0	0	C	(A)
2	0	0	LOOP CONTROLLER ADDRESS		(B)

(A) Block Header – 000D, 000E, 000F, and 000G
(B) Loop Controller Address

Extended Loop Status

The PLC uses the extended loop status command to gather data from:

- 4 analog inputs
- 2 frequency inputs
- 2 Contact inputs
- 2 analog outputs
- 2 contact outputs

This command can return data from only five consecutive loop controllers at a time. (Figure 14.) If you select more than five loop controllers, the interface module processes the controllers with the five lowest addresses.

All values in extended loop status file are in BCD and are expressed in percent of scale. The values can range from -2.0 to 102.0. (Figure 15.)

Figure 14
Extended Loop Status Command Format

Word #					
1	0	0	8	0	(A)
2	15 14 13 12	11 10 09 08	07 06 05 04	03 02 01 RS	(B)

(A) Block Header
(B) Loop Controller Select (RS=reserved)

Figure 15
Extended Loop Status File Format

0	0	8	0	(A)
15 14 13 12	11 10 09 08	07 06 05 04	03 02 01 RS	(B)
0	0	LOOP CONTROLLER ADDRESS		(C)
1	0	2	0	(D)
1	0	2	0	(E)
1	0	2	0	(F)
1	0	2	0	(G)
1	0	2	0	(H)
1	0	2	0	(I)
0	CI 1 & 2	0	C0 1 & 2	(J)
1	0	2	0	(K)
1	0	2	0	(L)

0	0	LOOP CONTROLLER ADDRESS		(N)
1	0	2	0	(D)
1	0	2	0	(E)
1	0	2	0	(F)
1	0	2	0	(G)
1	0	2	0	(H)
1	0	2	0	(I)
0	CI 1 & 2	0	C0 1 & 2	(J)
1	0	2	0	(K)
1	0	2	0	(L)

(A) Block Header
(B) Loop Controller Acknowledge
(RS = reserved)
(C) First Loop Controller Requested
(D) Input A
(E) Input B
(F) Input C
(G) Input D
(H) Input E
(I) Input F
(J) Contact In/Out
(K) Output 1
(L) Output 2
(M) Implied Decimal Point
(N) Last Loop Controller Requested

Contact Inputs (CI 1 & 2)

Bit 0 = Input 1 (0 = Open, 1 = Closed)

Bit 1 = Input 2 (0 = Open, 1 = Closed)

Contact Outputs (CO 1 & 2)

Bit 0 = Output 1 (0 = Open, 1 = Closed)

Bit 1 = Output 2 (0 = Open, 1 = Closed)

Error File

When the interface module cannot process a command other than a set control or an extended status command, an error file contains an error code identifying the problem. (Figure 16.)

Figure 16
Error Record Format

Word #				
1	0	0	8	0
2	COMMAND CODE		ERROR CODE	
3	0	0	LOOP CONTROLLER ADDRESS	

Error Code

01	Invalid loop controller address specified in the command
02	Address of the responding loop controller does not match the address requested by the interface module
03	Loop controller did not respond with a valid return code within three tries
04	Improper checksum was detected during a download operation
05	Improper BCD character in a data field
06	A modify parameters value is out of range
07	Module cannot execute a modify parameters, a download, or a set control command when the loop controller is in the panel mode. Loop controller must be in the workstation mode.
08	Modify parameters command requires additional data. This command expects 15 words of data. If some of the data is missing, an error is indicated.

Command Code

10	Modify parameters
20	Read parameters
04-07	Upload blocks 1 through 4
0C-0F	Download blocks 1 through 4

Specifications

Module Location
- 1771I/O Chassis

Operating Temperature
- 0 to 60° C
- 32 to 140° F

Storage Temperature
- -40 to 85° C
- -40 to 185° F

Relative Humidity Rating
- 5 to 95% (without condensation)

Electrical Interface
- RS-485 multi-drop up to 4000 ft

Maximum Number of Loop Controllers
- 15

Loop Status Update Time
- Approximately 2 sec/15 loops

Communication Rate
- 4800 baud
- Half duplex

Backplane Power Requirement
- 5VDC
- 1.3A

Keying
- Between 12 and 14
- Between 16 and 18

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